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A FLIGHT ASSESSMENT OF THE VIEW FROM THE T.S.R.2 BY SIMULATION IN A HUNTER 6

by

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R O Y A L A I R C R A F T E S T A B L I S H M E N T

(BEDFORD)

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by

O. P. Nicholas, B.Sc.(Eng)

SUMMARY

The structure of the cockpit of the T.S.R.2 has been simulated in a Hunter by blanking off areas of the windscreen and canopy with adhesive tape. Ten pilots have assessed the view from the cockpit in a variety of meteorological visibilities whilst flying at M = 0.9 at 200 feet above ground level, and on the approach to land. In the original design of cockpit canopy simulated the overhead members produced a serious obstruction to view in turns, but a second canopy design which was also simulated was found to be a great improvement. The pilots criticised the view from both T.S.R.2 cockpit designs simulated, as the windscreen pillars and arch were so wide for structural reasons, in order to provide adequate bird strike protection, that they caused considerable blind areas.

LIST OF CONTENTS

LIST OF APPENDICES

Appendix

LIST OF TABLES

Table

LIST OF ILLUSTRATIONS

1 INTRODUCTION

The design of the cockpit structure and transparencies of the T.S.R.2 is governed by the conflicting requirements of providing a good field of view for the pilot, and providing a structure which will withstand a bird strike and meet the thermal requirements of the high Mach number flight plans of the aircraft. The ultimate solution will inevitably be some compromise between these requirements. Proposals were made in the initial brochure for the assessment of the view from representative mock-ups. It is extremely difficult to make this assessment with any confidence from a fixed platform, and it was felt that a more representative simulation could be made by blanking off areas of the cockpit of another aircraft (a Hunter 6) to simulate the structure of the T.S.R.2. Flights could then be made in representative conditions and comments by the pilots, on the view from the aircraft, obtained.

This assessment was made between November 1959 and January 1960, by the pilots of Aero Flight R.A.E. Bedford, and by pilots from Vickers-Armstrongs and R.A.F. (A) Branch M.O.A. The view was assessed in high-speed low-level flight, and on the approach to land, and the comments of the pilots have been included as an Appendix to this note.

The T.S.R.2 has been designed for automatic operation at high speed at low level, so the pilot's view from the cockpit may not be as important as from a manually controlled aircraft in the same role. However the pilot must have a sufficiently good view to be able to monitor the automatic system, and to be able at least to return to base and land in the event of its failure.

2 THE METHOD OF SIMULATION

The flight conditions simulated were high speed low level flight and the approach to land.

The cockpits of the T.S.R.2 and Hunter are different in shape and size and are shown in side view, drawn to the same scale, in Fig.1. The eye position assumed for normal flying in the T.S.R.2 is shown as point X. As the aircraft will approach to land using a very nose-high attitude, the pilot will be required to raise his seat to obtain a better view over the nose of the aircraft; the estimated eye position in this case is shown as point Y. The assumed eye position in the Hunter remained constant throughout the tests and is shown as point Z.

The simplest method of simulating the windscreen and canopy structure of the T.S.R.2 was to represent this structure by sticking black adhesive tape to the inner surface of the Hunter windscreen and canopy. The areas to be blanked off were fixed by assuming that the angular positions of corresponding points in the T.S.R.2 and its simulation, measured from a point midway between the pilot's eyes, should be the same. Measurements were made on the T.S.R.2 windscreen using a viewing inclinometer set up at this point, and then the areas were marked on the Hunter windscreen using the same method. The roof members were marked out by external measurement on the canopy surface.

The simulation in the Hunter was compared with a mock-up of the actual T.S.R.2 by means of photographs taken from points X and Y in the T.S.R.2 mock-up and point Z in the Hunter. Since a wide field of view was required, a pinhole camera was used which had a field of view of 120° in asimuth and 50° in elevation. The field of view of the camera is shown in Fig.2a and typical photographs from the standard Hunter, a possible T.S.R.2 layout and the simulation of this layout in the Hunter, are shown in Figs.2b, 3a and 3b respectively.

The Hunter windscreen and canopy are closer to the pilot than those in the T.S.R.2, so the method of simulation used is not perfect when binocular vision and head movement are considered, since the Hunter structure and blanking were easier to see round than the corresponding structure in the T.S.R.2. In the Hunter one inch of eye movement is equivalent to 1.7° at the bottom of the windscreen (the farthest point in the cockpit from the pilot's eyes), and to 5.4° at the top of the windscreen. In the T.S.R.2 one inch of eye movement is equivalent to 1.0° and 3.7° respectively at these two points.

3 THE FLIGHT CONDITIONS AND THE CONFIGURATIONS ASSESSED

The flight conditions under which the assessment was made were:-

(a) M = 0.9 at 200 ft above ground level over flat terrain and sea, in straight and level and turning flight, in a variety of meteorological visibilities. The height above ground level was assessed with the aid of a radio altimeter.

(b) On the approach to land on a 3° glide path at 135 knots. Approaches, both straight and in cross winds (with the associated corrections to the approach path), were flown in a variety of meteorological visibilities.

(c) Incidental assessment during general flying and circuit conditions.

Two different designs of T.S.R.2 cockpit canopy were simulated. The first flights with a simulation of the cockpit design as it stood in November 1959 (T.S.R.2 configuration A), showed that the overhead canopy members produced a serious obstruction to view in turns. Another canopy design (T.S.R.2 configuration B) was therefore rapidly produced by Vickers-Armstrongs Limited to improve the view*, although it was not certain at the time whether it would be possible to overcome the constructional problems this introduced. This design of canopy was also simulated in the Hunter.

T.S.R.2 configuration A had an off-centre opening clam-shell canopy with the dividing line to starboard of the centre line. As seen when closed the canopy structure consisted of a wide overhead beam which extended further to the starboard of the aircraft centre line than to the port; this beam had a small window (offset slightly to port) at its forward end. Figs.3a and 9a are photographs from a mock-up of the T.S.R.2 configuration A, taken from points X and Y respectively (see Section 2). The fields of view derived from these photographs are shown in Figs.4a and 10a respectively.

T.S.R.2 configuration B had a symmetrical centre-opening clam-shell canopy, the canopy structure (as seen when closed) consisting of a single relatively narrow central beam. The field of view from point X in T.S.R.2 configuration B is shown in Fig.6a; this was derived from Fig.4a with allowance for the change in overhead canopy members.

The field of view diagrams were derived from the pinhole camera photographs with the aid of a photograph of a 5° grid (Fig.2a), and have been corrected to a frame of reference which is parallel to the horizontal when in flight. The portions of the diagrams that lie outside the camera's field of view are based on firm's data and are shown by dotted lines.

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*A cockpit canopy with a structure very similar to that of T.S.R.2 configuration B, but opening in a different manner, has since been adopted for the T.S.R.2.

The Hunter was assessed in five configurations.

(a) At M = 0.9 at low level (T.S.R.2 eye position X)

Hunter configuration 1

Standard Hunter with gun-sight removed. This is shown in the photograph Fig.2b, from which the field of view Fig.2c has been derived.

Hunter configuration 2

Simulation of T.S.R.2 configuration A. The Hunter is shown in the photograph Fig.3b, from which the field of view Fig.4b has been derived, and in the general view Fig.5.

Hunter configuration 3

The field of view of T.S.R.2 configuration B is shown in Fig.6a, and the simulation of this in the Hunter configuration 3 is shown in the field of view Fig.6b and the general view Fig.7. The only change from Hunter configuration 2 was in the overhead canopy structure, and this can be seen by comparing Fig.5 and Fig.7.

Hunter configuration 4

Simulation of T.S.R.2 configuration A. The Hunter is shown in the photograph Fig.8a, from which the field of view Fig.8b has been derived. This field of view was the same as Hunter configuration 2 except for the simulated front windscreen pillars which were displaced from their correct position, so as to lie over the Hunter pillars. The correct area of structure was therefore simulated but the front windscreen was too wide. This configuration was assessed to see whether the elimination of the second pair of pillars would alter the opinions formed when flying the other configurations.

(b) On the approach to land (T.S.R.2 eye position Y)

Hunter configuration 5

Simulation of T.S.R.2 configuration A. The Hunter is shown in the photograph Fig.9b from which the field of view Fig.10b has been derived, and in the general view Fig.11.

The conditions assessed by means of the different Hunter configurations are summarised in Table 1, in which the relevant figures are listed and comments on the details of the simulations are presented.

4 THE PILOTS' ASSESSMENTS

In its various configurations the Hunter was flown over flat terrain by 10 different pilots - (7 R.A.E., 2 Vickers Armstrongs, 1 R.A.F.(A) Branch M.O.A.).

Early in the tests it was found that meteorological visibility had a marked influence on the pilots' assessment of a given cockpit configuration. A configuration which was acceptable in good visibility might become unacceptable in poor visibility, as the need increased for continuous searching to make sure that the path of the aircraft was free from danger of collision with ground obstructions or other aircraft. Some idea of the sensitivity of pilots to small obstructions in the cockpit when making these assessments may be obtained from their request to have the emergency compass removed from the Hunter, since they felt that it might affect their

assessment. This compass was at the top of the port side panel of the windscreen (Figs.2b and 3b), and was removed after the first two flights of Hunter configuration 2.

The standard Hunter has a good view from the cockpit, and pilots found that the considerable increase in blind areas produced by the T.S.R.2 simulation was most undesirable, particularly when flying in poor meteorological visibility. Criticism was directed particularly at the large obstruction to view produced by the overhead canopy, and by the intersection of this with the windscreen arch and pillars, in one possible T.S.R.2 layout simulated (T.S.R.2 configuration A, Hunter configurations 2, 4 and 5). A second design of overhead canopy structure which was also simulated (T.S.R.2 configuration B, Hunter configuration 3) produced a great improvement in both these aspects of the view. Other points of criticism which applied to both the possible T.S.R.2 layouts simulated were the width of the windscreen arch and windscreen pillars, both of which markedly reduced the view and therefore caused anxiety when flying at high speed in poor visibility.

The pilots' assessments of the different Hunter configurations are summarised in Table 2 and more detailed pilots' comments are given in Appendices 1 and 2.

5 CONCLUSIONS

An assessment of the view from the cockpit of the T.S.R.2 has been made by 10 pilots, using a Hunter 6 aircraft in which blind areas caused by the structure of the T.S.R.2 were simulated by blanking off areas of the windscreen canopy. The areas to be blanked off were fixed by assuming that the angular positions of corresponding points in the T.S.R.2 and its simulation, measured from a point midway between the pilot's eyes, should be the same. This method was limited in realism, as the Hunter windscreen and canopy were nearer to the pilot than those in the T.S.R.2, so that the improvement in view due to head movements and binocular vision was greater in the simulation than in the actual T.S.R.2.

The principal comment of the pilots was that compared with the Hunter, which has a good view from the cockpit in all roles, there was a considerable increase in the blind areas caused by structure in the cockpit. These became increasingly apparent when flying at high speed as meteorological visibility decreased.

The main points of criticism were:-

(i) The front pillars, which if reduced in width would have allowed a better forward view.

(ii) The windscreen arch, which caused a large blind area.

(iii) The overhead canopy structure.

(a) With original off-centre opening. The overhead structure in combination with the windscreen arch and pillars, caused a large obstruction to the view in moderately banked turns. The overhead window could be used in steep turns but it would have been of more use if it had been continued further aft.

(b) With central opening. This was a great improvement on (a) but the overhead structure would still be objectionable in a fighter role.

6 FURTHER DEVELOPMENTS

The canopy finally adopted for the T.S.R.2 is similar to T.S.R.2 configuration B, but has a narrower central member and opens rearwards. Other detail changes in the cockpit design have also been made.

Vickers-Armstrongs Limited plan to have further flights in a Hunter to assess a simulation of the final design.

ATTACHED:

Appendices 1 and 2
Tables 1 and 2
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APPENDIX 1

THE ASSESSMENT OF A SIMULATION OF THE VIEW FROM THE COCKPIT OF THE T.S.R.2

by

Pilots of R.A.E. Bedford

1 INTRODUCTION AND CONDITIONS

In order to obtain pilots' impressions in flight of the proposed T.S.R.2 canopy and windscreen, the canopy and windscreen of a Hunter 6 were blanked off to give a similar field of view. This field of view was established by comparing photographs taken with a pinhole camera mounted in the T.S.R.2 cockpit mock-up and in the Hunter, and can only accurately simulate a "one eyed pilot" who never moves his head.

The flights were made over sea or very flat terrain, and therefore remarks about obstruction to view at various bank angles do not allow for hilly surroundings.

This report is a summary of the remarks of seven R.A.E. pilots.

2 PILOTS' ASSESSMENTS

2.1 M = 0.9 at low level

2.1.1 Hunter configuration 1 (Standard Hunter, minus gun-sight)

The view was good to very good, due to the light structures employed. The windscreen pillars were narrow enough to "see through" and so were little obstruction to vision. However some criticisms can be made of the view in turning flight. The emergency compass was an appreciable obstruction to view in a 30° bank turn to port. At over 35° of bank the windscreen arch obscured a useful part of the horizon, but only a small head movement was required to see round it, although this was difficult under high normal acceleration.

2.1.2 Hunter configuration 2

In straight and level flight at 200 to 300 feet above ground level, the downward view ahead and to the sides was quite good but there was considerable obstruction of the forward panoramic view by the windscreen side pillars. This was partly exaggerated by the extra Hunter pillars, but, even where the pillars were almost coincident, there was still a width of pillar which was difficult to "see through". This obstruction to view was made all the more evident by the narrow front windscreen. In good visibility the obstruction was of little consequence but in limited visibility the presence of the pillars was increasingly felt, as they formed a positive break in the forward vision in an area in which it was necessary to scan continuously while looking for landmarks and obstructions. In level flight, there was no real obstruction from the canopy as the side windows were adequate in depth and continued far enough aft to provide a reasonable view. There was, however, a large cut-off due to the windscreen arch, but this was far enough away from the line of flight to be of little consequence. In poor light conditions the presence of the extra structure in the canopy made the Hunter cockpit seem fairly dark.

In turning flight, the asymmetric canopy structures (see Section 3 of main report) completely obscured the horizon in turns of about 50° bank to

starboard and 60° bank to port, and in anything except poor visibility these bank angles were exceeded to obtain a reasonable rate of turn. When manoeuvring in good visibility the top window was used to help in seeing that the path of the aircraft was clear, but as the window did not extend very far aft it was of limited use. In good visibility the principal obstruction was the windscreen arch, which, combined with the top of the front pillars and forward part of the canopy structures, effectively blanked out the view of the intended flight path. This obstruction to view was continuous back into the top canopy structure unless the angle of bank was about 75°, when the top window could be used.

In poor visibility, it was generally found that bank angles of about 40° were not exceeded and under these conditions the canopy structure was still above the horizon, over flat terrain, and did not cause an obstruction to the view of the ground. On these occasions, the desired line of sight was usually through the front windscreen which just allowed one to see the flight path. The real obstruction was caused by the width of the front pillars, as, in a turn, the lower one was lying just below the horizon and blanking out a large percentage of the desired field of view. The windscreen arch formed a very positive barrier to more rearward view although, in conditions of poor visibility and no horizon, there was little desire to see further aft.

2.1.3 Hunter configuration 3

The reduction in the overhead canopy structure to a single central member made a very great improvement to the overhead view in steeply banked turns and allowed more light into the cockpit. About 75° of bank was required to put the bar on the horizon, over flat terrain, and whenever this bank angle was used the circumstances were such that a limit on upward view was not of a serious nature. All the remarks about the front windscreen and arch in para. 2.1.2 still apply in this case, although the very presence of more peripheral view in steep turns made some of the shortcomings of the front screen more bearable.

2.1.4 Hunter configuration 4

This configuration was assessed to see whether the elimination of the extra Hunter pillars would alter the opinions formed in the earlier flying. It was appreciated that the front windscreen would now be much wider than the T.S.R.2 screen.

The improvement in view produced by this change was very marked, and was almost entirely due to the extra width of the front windscreen. It was thought that the actual width of the windscreen pillars was still too great to "see through" and this became increasingly apparent as meteorological visibility decreased.

2.2 On the approach to land

Hunter configuration 5

The downward view on the approach was sufficient for even a very flat approach in the Hunter at 135 knots. On a straight approach in good visibility, there was no real inconvenience from the front pillars even in a 15 knot cross wind, and the general forward view was thought to be quite good. In hazy conditions, the front pillars became quite an obstruction when looking for the runway lights from about two to three miles range, and it was felt that in poor visibility they would be a serious handicap if the aircraft was not quite lined up with the runway on reaching visibility distance from an

instrument approach. When making a visual circuit in poor visibility, the windscreen arch presented a very objectionable obstruction when banked on the final turn, and this made it very difficult to keep the runway in sight.

3 CONCLUSIONS

In good visibility, there was nothing really unpleasant about the view at high speed apart from the considerable obstruction to view caused by the canopy structures in steep turns, and it was felt that, as a simple improvement, it would be of advantage to make the top window continue further aft. The flights made in Hunter configuration 3 showed that the canopy with a single central member was an acceptable arrangement, and caused serious obstruction only in very steep turns when some loss of upward view would probably be acceptable. This overhead blind spot would probably still be objectionable in an aircraft required to perform a fighter role.

With the visibility anything less than good, there was considerable criticism of the width of the front pillars, combined with the narrow front windscreen and the very wide windscreen arch. The limitations in view thereby imposed increased as the meteorological visibility decreased and it was considered that, for an aircraft which was being designed to operate in all weathers at low level, possibly with some unserviceability of automatics or navigation aids, the existing amount of structure was unacceptable. The reduction in vision in poor visibility is accentuated by the reduced time available to see obstructions when flying at low level, and therefore any blind spots make it desirable to reduce speed. It was realised that severe structural requirements were having to be met on this aircraft, but it was felt that the problems of the present restrictions to vision would have to be balanced against those of easing the structural requirements.

This same effect of the accentuated reduction in vision also applied on the landing approach in poor visibility, when the time taken to see the runway or approach lights decreased the chances of making a successful approach.

It was considered that the greater distances from the pilot's eyes to the structure in the actual T.S.R.2 cockpit would make conditions worse than those present in this simulation.

4 RECOMMENDATIONS

It is considered essential that the obstruction to view caused by the front windscreen pillars be reduced by either optical or structural means, and that the rear arch of the windscreen be redesigned to give a better view, even if this means a slight reduction in the structural strength of the windscreen.

It is recommended that the canopy be made to open centrally (as in the modified configuration) to improve the upward view and that the width of the overhead obstruction be kept to the absolute minimum. Everything possible should still be done to try to make the canopy completely clear, even at the possible expense of ejection times. If the canopy has to open off-centre, the top window should be continued further aft.

APPENDIX 2

THE ASSESSMENT OF A SIMULATION OF THE VIEW FROM THE COCKPIT OF THE T.S.R.2

by

Pilots of Vickers-Armstrongs (Aircraft) Ltd.

HUNTER CONFIGURATION 2 ONLY

The aircraft was flown at 200 feet at or near 600 knots for a considerable period to assess the view. The flights included periods over land and sea.

The results can be briefly summarised as follows:-

(i) Forward view was marginal, though not patently unacceptable. The view forwards and upwards was extremely poor due to the heavy arch/top beam intersection.

(ii) When the aircraft was banked 45° the horizon disappeared completely. This angle of bank was considered to be that normally used in these flight conditions. At higher bank angles (which were not pleasant at such low altitude) the horizon could just be seen through the 8" x 6" panel which has been inserted at the forward end of the top beam to afford a view of the horizon in the L.A.B.S. manoeuvre. This aspect of the view was considered unacceptable.

TABLE 1

Details of simulations

Hunter configuration	Figures		Flight condition	Details of simulation
	T.S.R.2	Hunter		
1		2b 2c	M = 0.9 low level	Standard Hunter with gun-sight removed
2	3a 4a	3b 4b 5	M = 0.9 low level	T.S.R.2 configuration A:- Off centre opening canopy having a wide overhead member with a small window in it. Fig. 3b shows the emergency compass (at the top of the port side panel); this was removed after two flights (see Section 4). In Fig. 4b the emergency compass is not shown. The simulated thickness of the windscreen arch is approximately 20% too small.
3	6a	6b 7	M = 0.9 low level	T.S.R.2 configuration B:- Central opening canopy having a single relatively narrow overhead member. Windscreen arch and pillars as in Hunter configuration 2.
4	3a 4a	8a 8b	M = 0.9 low level	T.S.R.2 configuration A:- In Hunter configuration 2 the front pillars of the Hunter and simulated T.S.R.2 largely lay side by side. In Hunter configuration 4 the correct width of the T.S.R.2 pillars was simulated, but displaced to lie over the Hunter pillars, and the front screen simulation was in consequence too wide. Windscreen arch and canopy as in Hunter configuration 2.
5	9a 10a	9b 10b 11	Approach	T.S.R.2 configuration A.

TABLE 2

Pilots' assessments

Hunter configuration	Figures		Flight condition	Pilots' assessment (from flights over flat terrain)
	T.S.R.2	Hunter		Assessments are summarised for each configuration under the following headings:- 1. Downward view, ahead and to the side. 2. Forward view. 3. Intersection of windscreen arch and pillars, and canopy structure. 4. Obstruction to view in turns, produced by canopy structure. 5. Miscellaneous.
1		2b 2c	M = 0.9 low level	1. Good 2. Good 3. The arch obscured a useful part of the horizon in turns at over 35° of bank, but it could be seen round by making a small head movement. 4. Not applicable as the Hunter has no canopy structure. 5. The emergency compass (top of port side panel) was an appreciable obstruction to view in turns.
2	3a 4a	3b 4b 5	M = 0.9 low level	1. Good 2. The wide front pillars combined with the narrow front screen caused a deterioration in the view which was particularly noticeable in poor meteorological visibility. 3. A particularly bad blind area existed which was most embarrassing at over 40° of bank; this angle was exceeded in turns except when the meteorological visibility was poor. 4. Severe loss of view; the top window was of use in steep turns (over 75° of bank) but did not extend far enough rearwards. 5. After the first two flights in this configuration the emergency compass (top of port side panel) was removed at the pilots' request (see Section 4).
3	6a	6b 7	M = 0.9 low level	1. As configuration 2. 2. As configuration 2. 3. Obstruction to view still existed but was much less serious than in configuration 2. 4. No serious obstruction to view, but the opaque area was still large enough to be undesirable in a fighter role.

TABLE 2 (Cont'd.)

Hunter configuration	Figures		Flight condition	Pilots' assessment (from flights over flat terrain)
	T.S.R.2	Hunter		Assessments are summarised for each configuration under the following headings:- 1. Downward view, ahead and to the side. 2. Forward view. 3. Intersection of windscreen arch and pillars, and canopy structure. 4. Obstruction to view in turns, produced by canopy structure. 5. Miscellaneous.
4	3a 4a	8a 8b	M = 0.9 low level	1. A marked improvement on configuration 2, almost entirely due to wider front windscreen. 2. As configuration 2. 3. As configuration 2. 4. As configuration 2.
5	9a 10a	9b 10b 11	Approach	1. Satisfactory in the conditions represented. 2. Satisfactory in good meteorological visibility becoming poor in poor visibility. 3. Not important. 4. Not important. 5. The windscreen arch was a considerable obstruction to view when making the final turn.
2,3,4 and 5			General flying	5. The areas of windscreen and canopy cut-off considerably increased the risk of mid-air collision.

FIG. 1 (a&b)

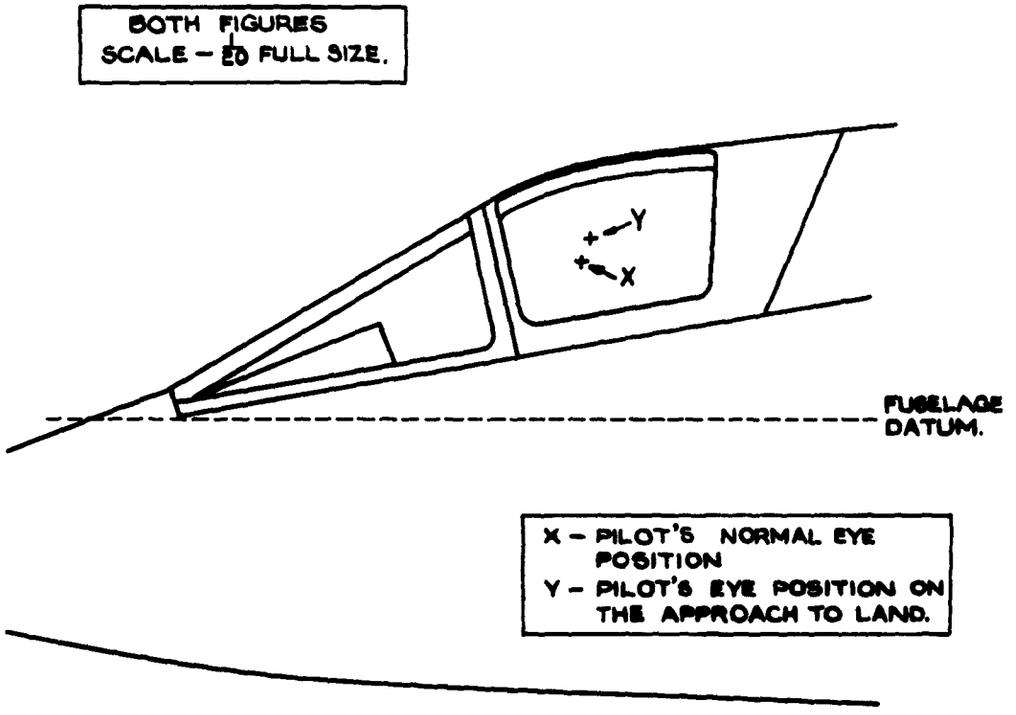

FIG. 1(a) SIDE VIEW OF THE T.S.R.2. COCKPIT.

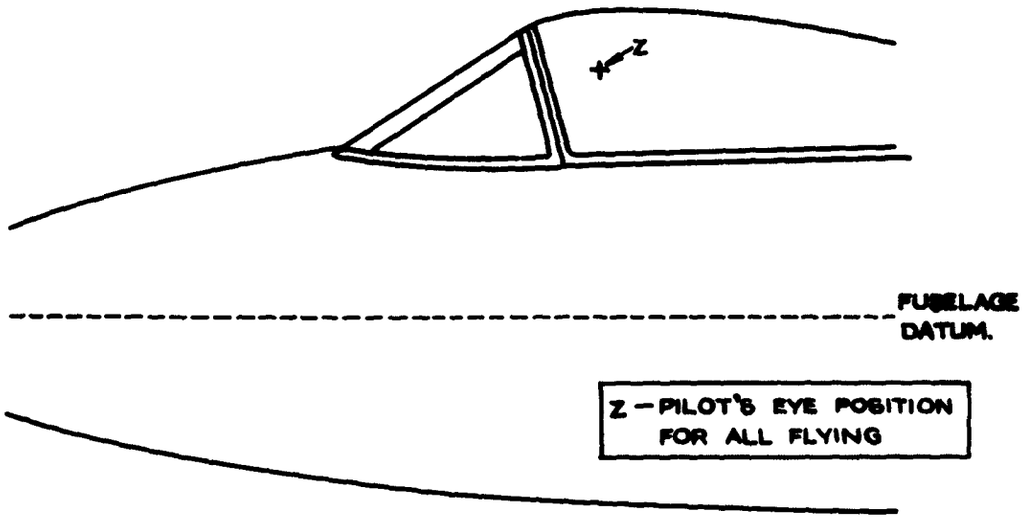

FIG. 1.(b) SIDE VIEW OF THE HUNTER COCKPIT.

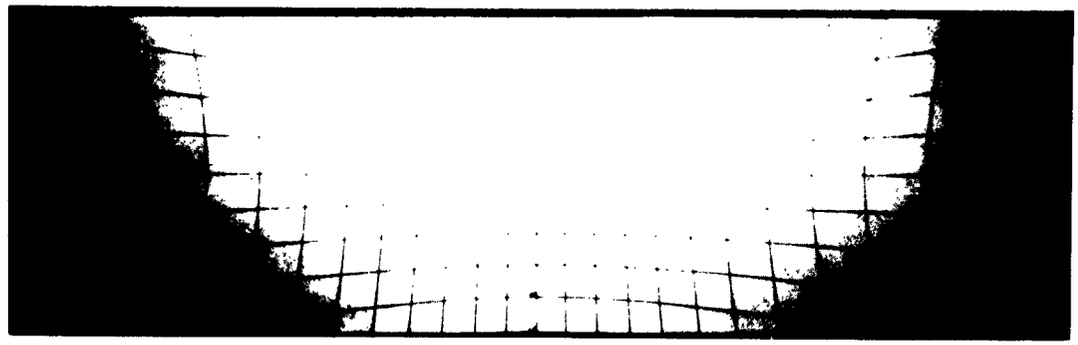

FIG.2a. FIELD OF VIEW OF PINHOLE CAMERA, SHOWING 5° GRID

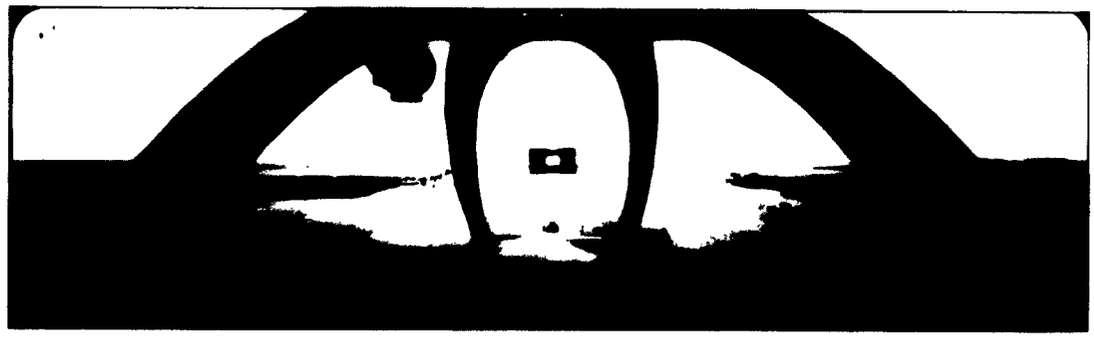

FIG.2b. HUNTER CONFIGURATION 1, FROM POINT Z

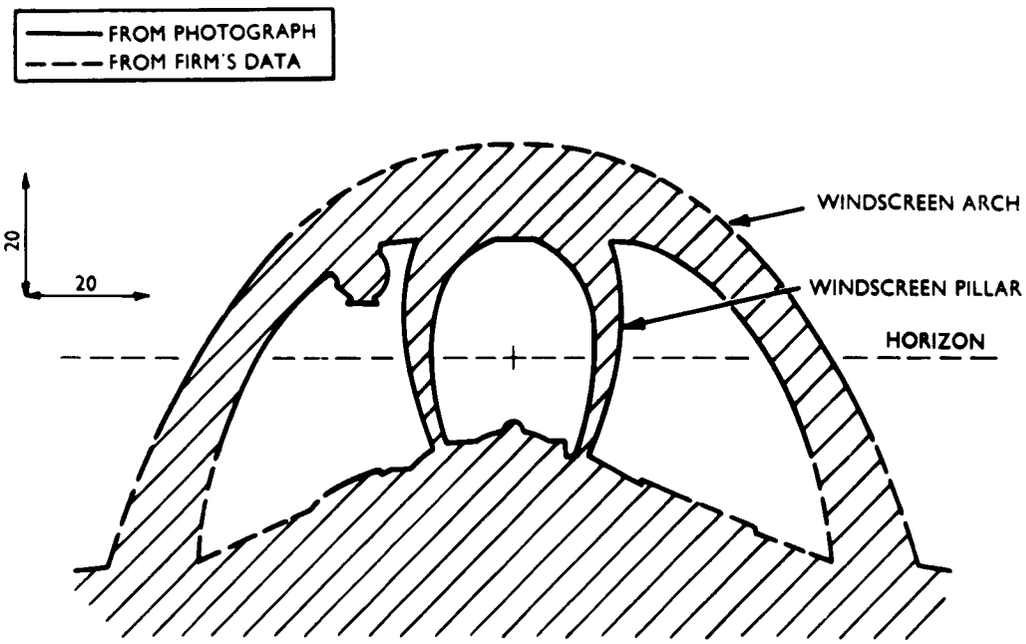

FIG.2c. FIELD OF VIEW FROM HUNTER CONFIGURATION 1, POINT Z AT M=0·9 AT LOW LEVEL

R.A.E. 152297 61

FIG.3a. T.S.R.2. CONFIGURATION A, MOCK-UP FROM POINT X

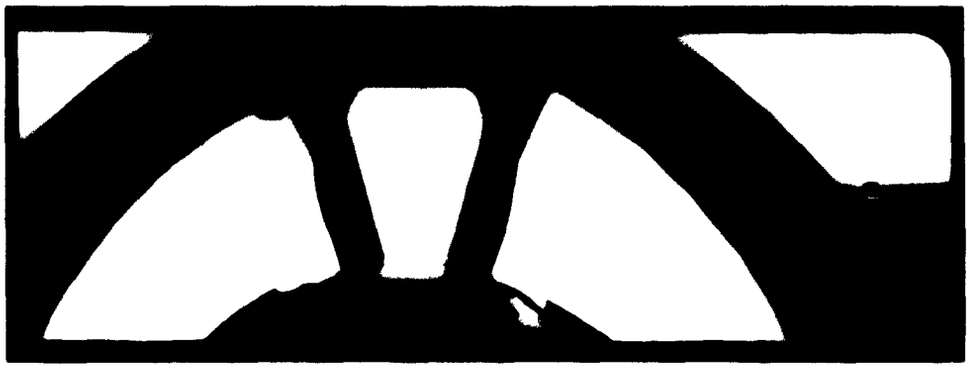

FIG.3b. HUNTER CONFIGURATION 2, FROM POINT Z

R.A.E. 152298 61

FIG. 4(a&b)

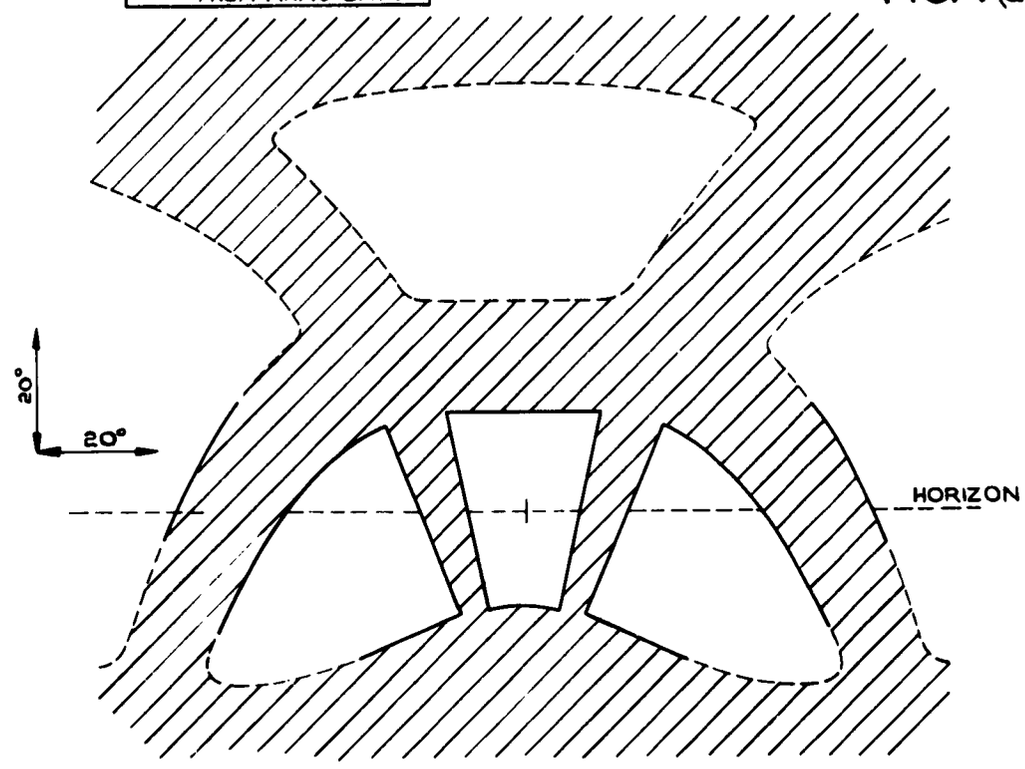

FIG. 4(a) FIELD OF VIEW FROM T.S.R.2.
CONFIGURATION A POINT X, AT M=0·9 AT LOW LEVEL.

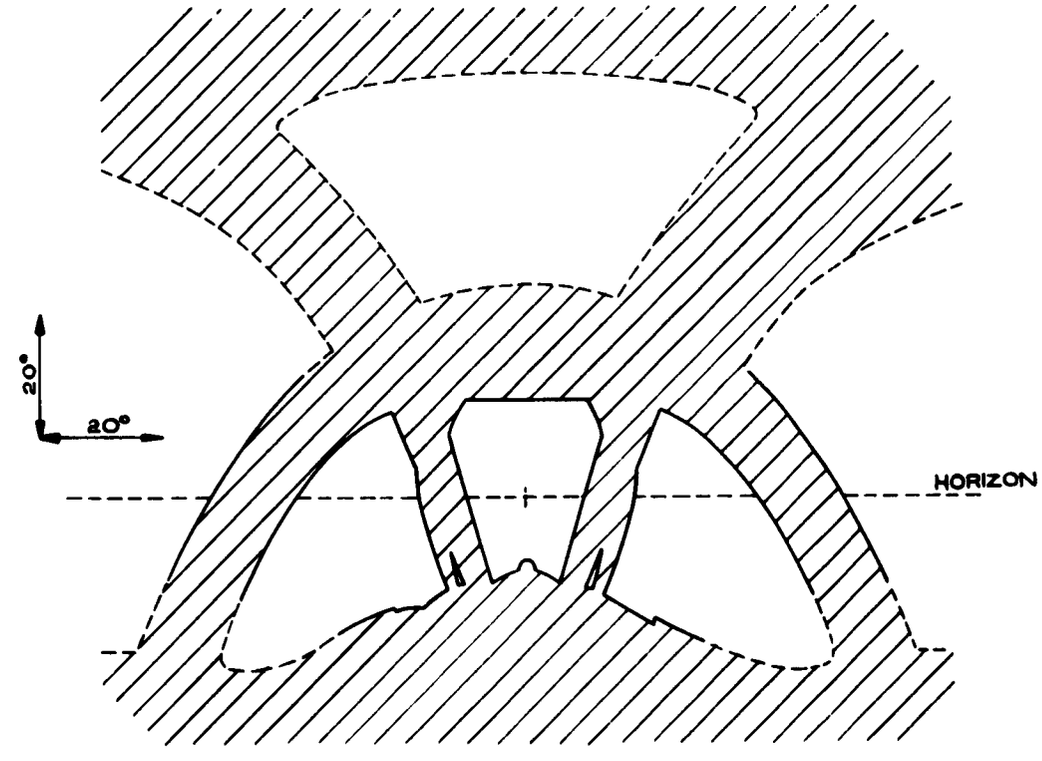

FIG. 4(b) FIELD OF VIEW FROM HUNTER
CONFIGURATION 2 POINT Z, AT M=0·9 AT LOW LEVEL.

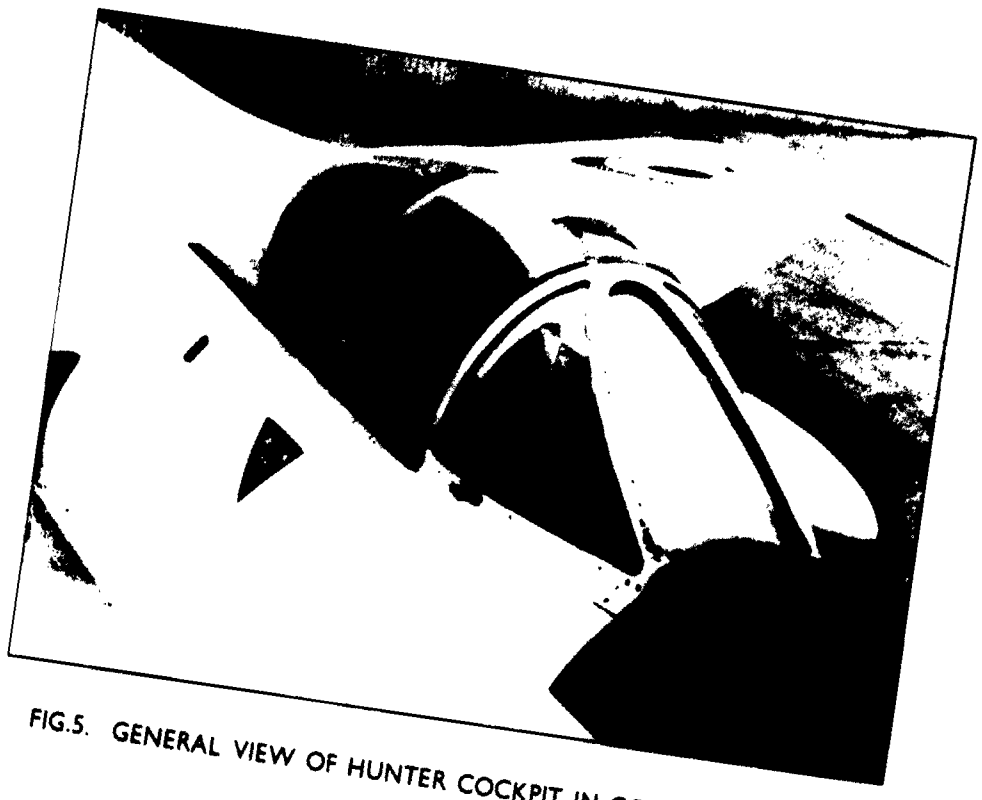

FIG.5. GENERAL VIEW OF HUNTER COCKPIT IN CONFIGURATION 2

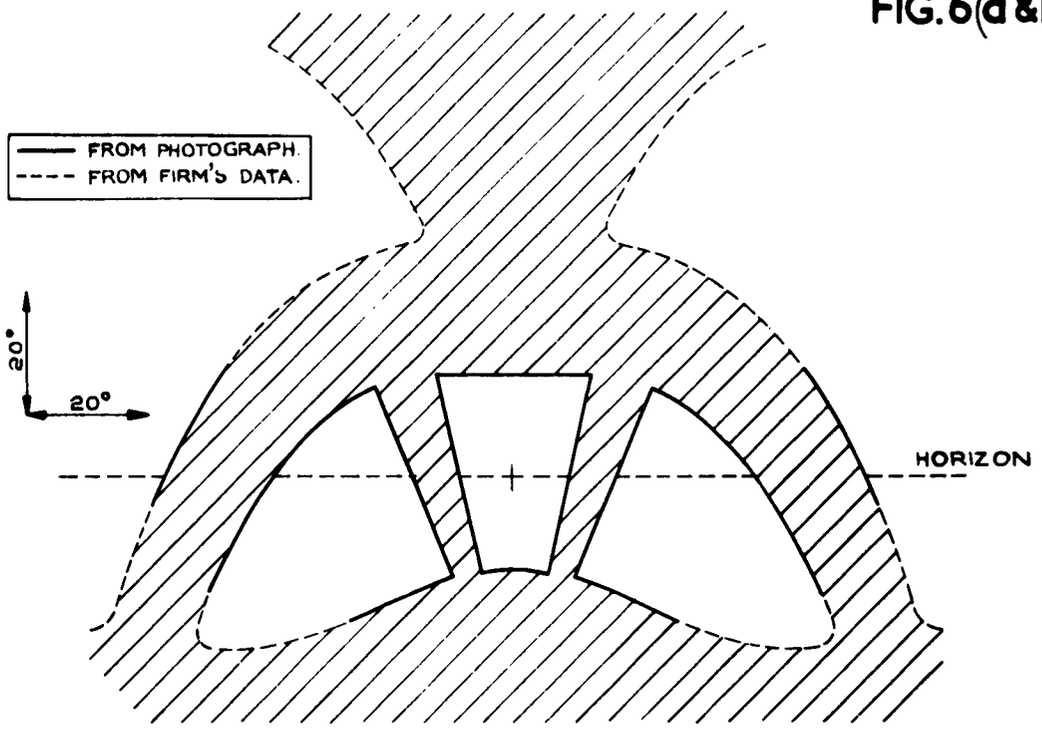

FIG. 6.(a) FIELD OF VIEW FROM T.S.R.2.
CONFIGURATION B POINT X, AT M=0·9 AT LOW LEVEL.

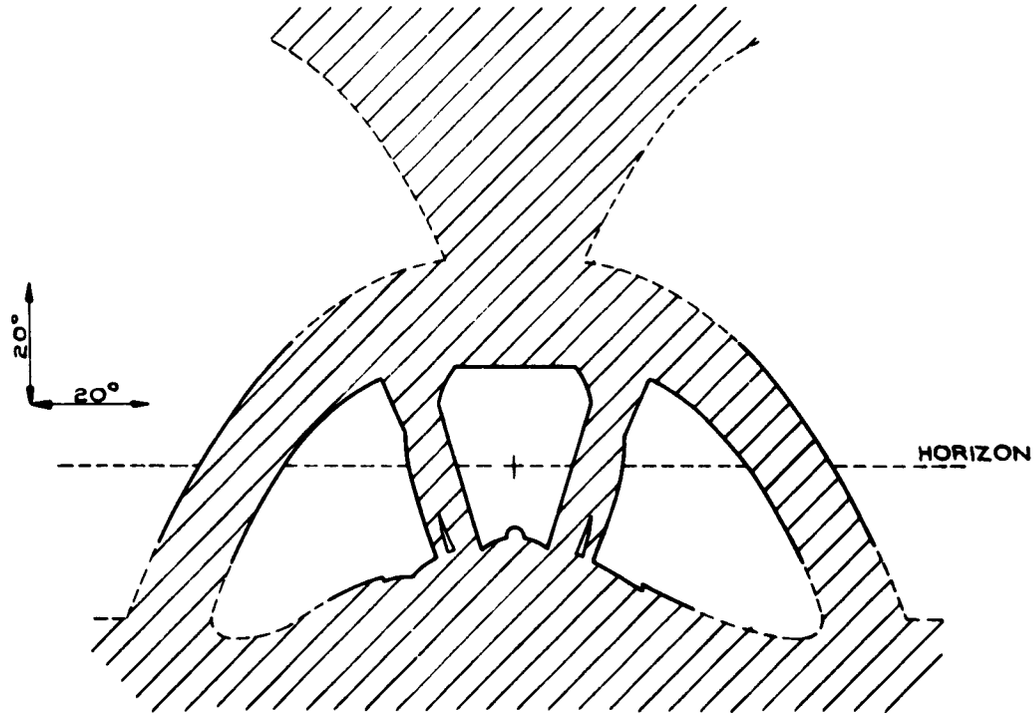

FIG. 6.(b) FIELD OF VIEW FROM HUNTER
CONFIGURATION 3 POINT Z, AT M=0·9 AT LOW LEVEL.

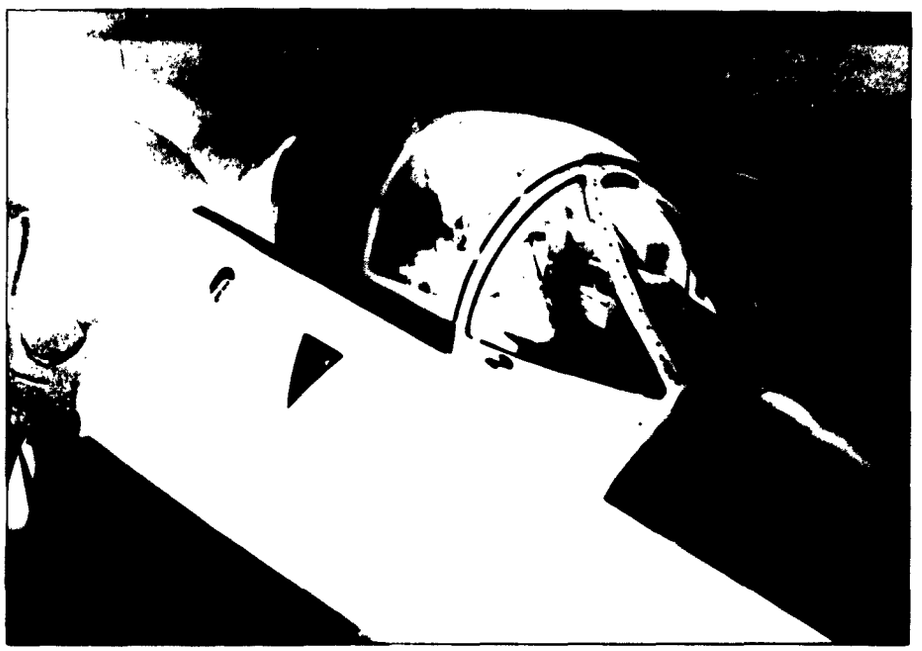

FIG.7. GENERAL VIEW OF HUNTER COCKPIT IN CONFIGURATION 3

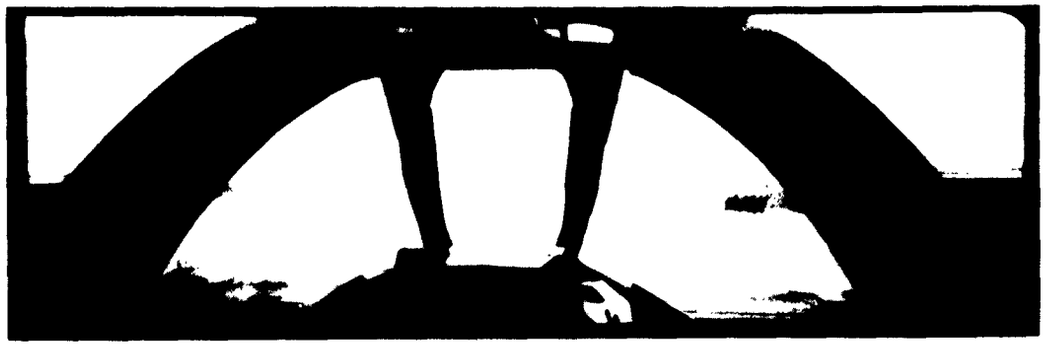

FIG.8a. HUNTER CONFIGURATION 4, FROM POINT Z

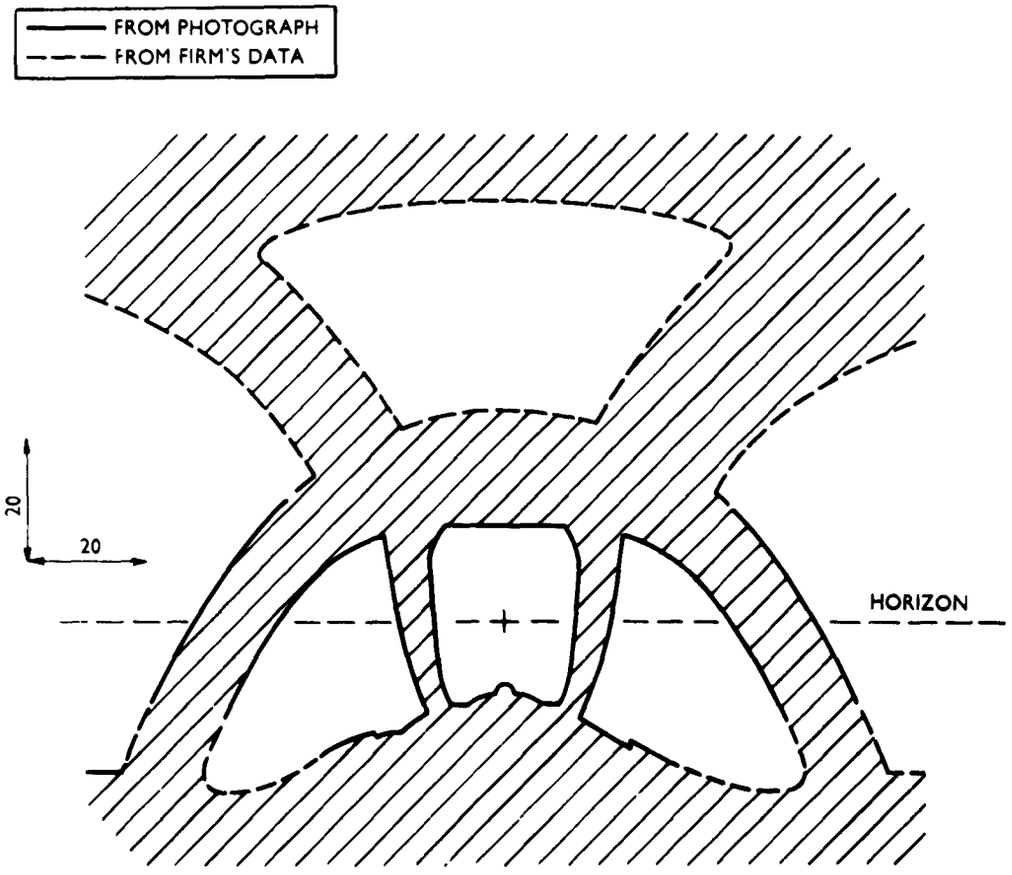

FIG.8b. FIELD OF VIEW FROM HUNTER CONFIGURATION 4, POINT Z AT M 0·9 AT LOW LEVEL

R.A.E. 152301 61

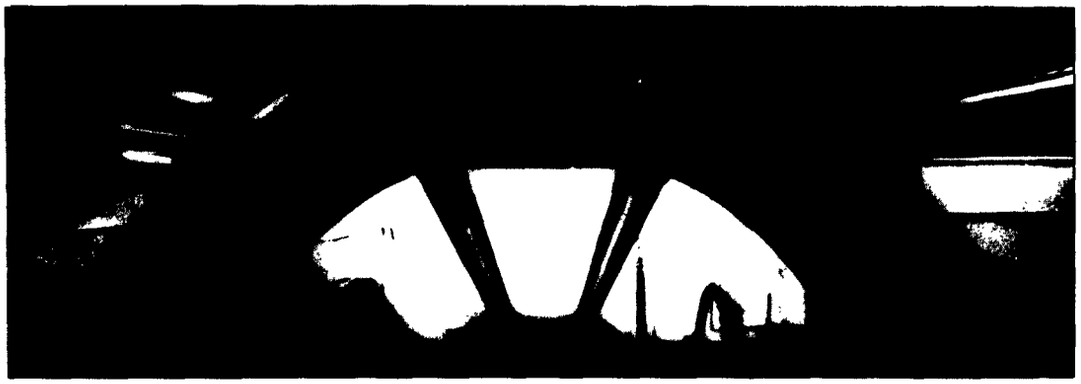

FIG.9a. T.S.R.2. CONFIGURATION A, MOCK-UP FROM POINT Y

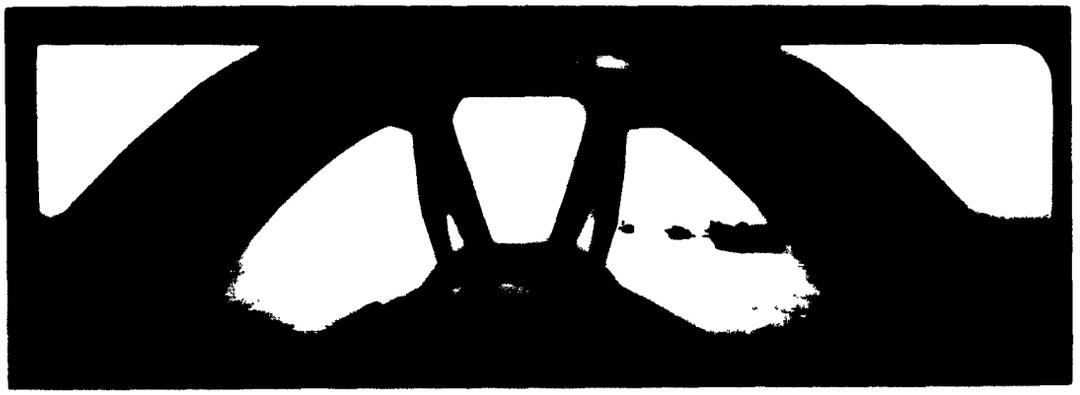

FIG.9b. HUNTER CONFIGURATION 5, FROM POINT Z

R.A.E. 152302 61

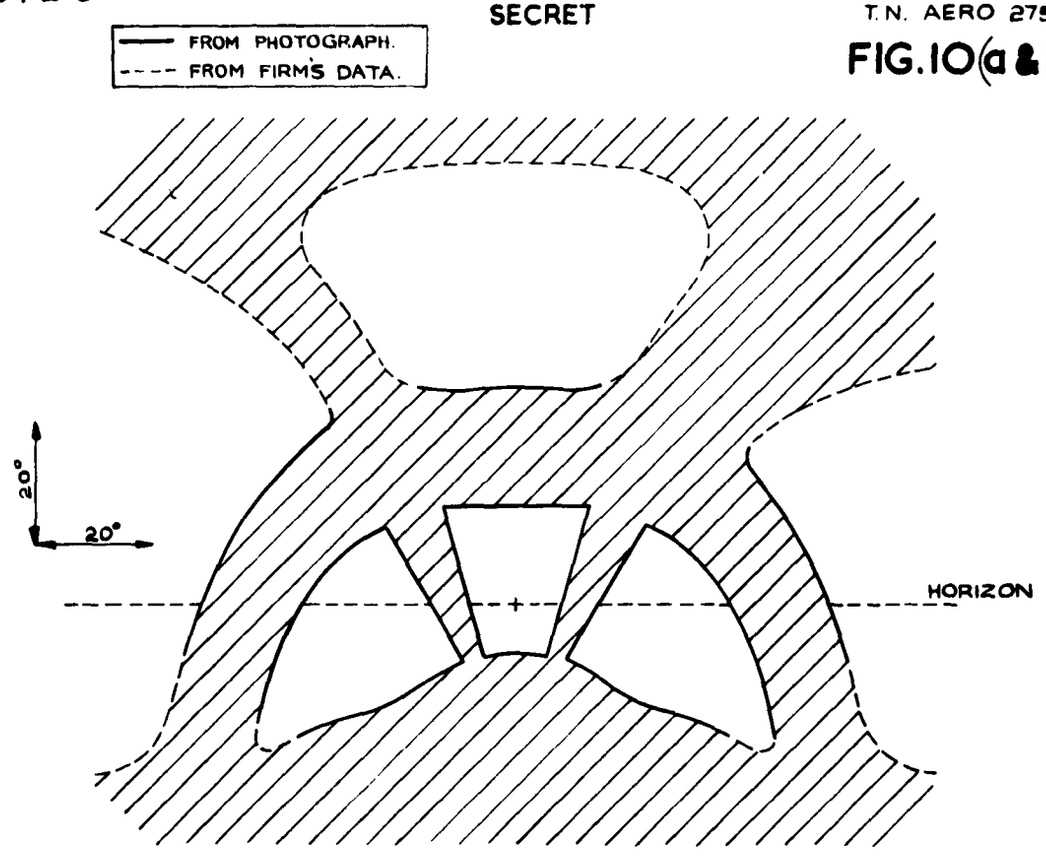

FIG. 10(a) FIELD OF VIEW FROM T.S.R.2. CONFIGURATION A POINT Y, ON THE APPROACH.

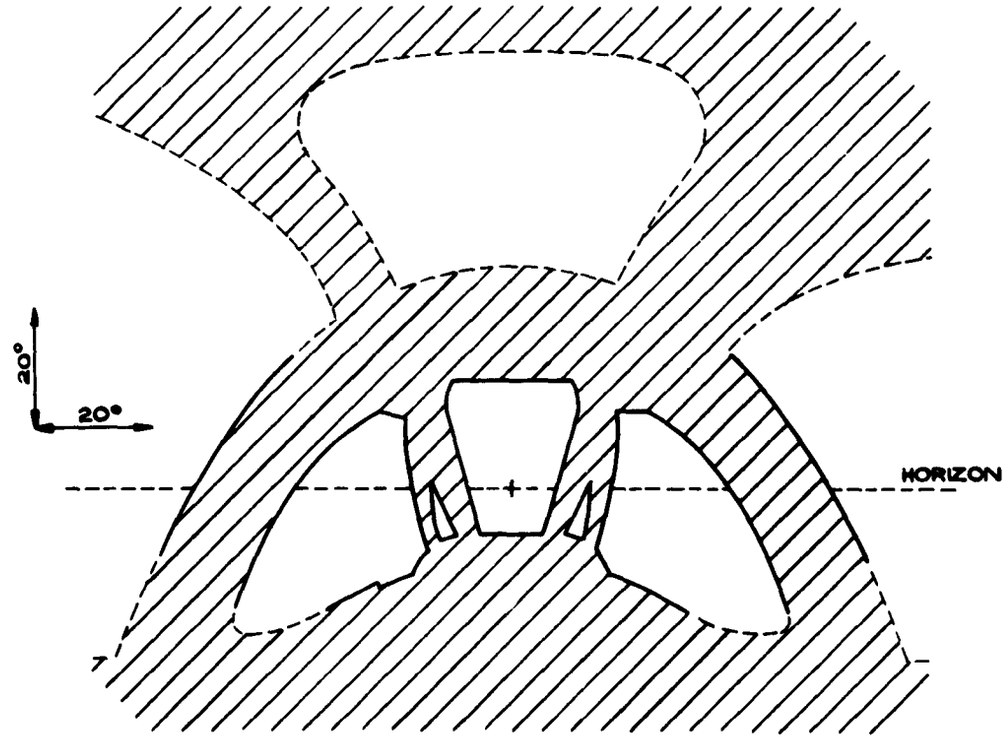

FIG. 10.(b) FIELD OF VIEW FROM HUNTER CONFIGURATION 5 POINT Z, ON THE APPROACH.

FIG.11. GENERAL VIEW OF HUNTER COCKPIT IN CONFIGURATION 5

R.A.E. 152303 61

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Technical Note No. Aero. 2755
Royal Aircraft Establishment

A.I. TSR-2:
629.13.012.134:
159.931

A FLIGHT ASSESSMENT OF THE VIEW FROM THE T.S.R.2 BY SIMULATION IN A HUNTER 6. Nicholas, O.P. Apr. 1961.

1.7.1.2
1.3.3
9.2

The structure of the cockpit of the T.S.R.2 has been simulated in a Hunter by blanking off areas of the windscreen and canopy with adhesive tape. Ten pilots have assessed the view from the cockpit in a variety of meteorological visibilities whilst flying at M = 0.9 at 200 feet above ground level, and on the approach to land. In the original design of cockpit canopy simulated the overhead members produced a serious obstruction to view in turns, but a second canopy design which was also simulated was found to be a great improvement.

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The pilots criticised the view from both T.S.R.2 cockpit designs simulated, as the windscreen pillars and arch were so wide for structural reasons, in order to provide adequate bird strike protection, that they caused considerable blind areas.

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